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Vibration levels of machinery

In order to attempt to establish the severity of machinery problems, one generally attempts to observe overall levels of vibration, or levels of vibration at particular frequencies. Occasionally, attempts to relate phase angles of such measurements as rotative speed vibration of the housing versus the shaft are attempted.

On particular machines, for particular normal or abnormal operations, one or a combination of these vibration measurements may be right-on. In general, however, a deeper view is required.

Vibration is usually either the result of a bowed rotor or is the result of a force or moment acting on the stiffness of the machine to that force or moment. As such, vibration is actually a ratio and frequently not an end objective measurement in itself. Remember that forces and moments flow through, motions are measured across, and:

$$\text{Dynamic Motion (vibration)} = \frac{\text{Dynamic forces or Moments}}{\text{Dynamic Stiffness}}$$

Thus, to best read the behavior of a machine, it is often necessary to know BOTH the numerator and the denominator of this simple relationship.

As an example, a shaft-observing probe reads 4.73 mils pp at 256 degrees lag at rotative speed. The synchronous stiffness at that speed, at that observed position, is supposed to be 10^6 lb/in at 115 degrees lag. If an unbalance force creates this motion, then the force is:

$$(10^6 \text{ lb/in}) \frac{4.73 \text{ mils pp}}{2000 \text{ mils pp/in}} = 2365 \text{ lbs.}$$

Note: There are 1000 mils per inch, and 2 mils pp per 1 mil 0-p, therefore 2000 mils pp/in.

Alternatively, the observed synchronous stiffness could be three times higher, and the force could be three times higher. Obviously, you must make some sort of assumption of stiffness or force in order to have a knowledgeable vibration measurement. We do this regularly and will continue to do so. However, to improve our capabilities of operating machinery, the measurement of observed operating dynamic stiffness will become more important in the future, as either the numerator (Dynamic Forces) may be incorrect, or the denominator (Dynamic Stiffnesses) may be incorrect. ■